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Bulletin of the
Society for the Promotion of Engineering Education

Vol. VIII LANCASTER, PA., JUNE, 1918 . No. 10

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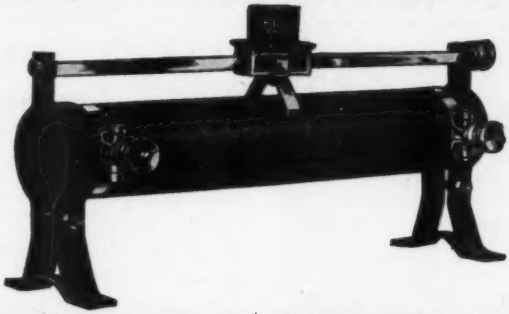

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AN EXPERIMENT IN TEACHING.

BY F. G. HIGBEE,

Professor and Head, Department of Descriptive Geometry and Drawing, State University of Iowa.

What is the best method of presenting facts to students?

Do they learn more quickly by studying from a text-book, or by hearing this same subject-matter explained by an instructor and illustrated on the blackboard?

The following data are presented here in the belief that they throw some light into this rather obscure angle of teaching.

The Problem.—The subject-matter to be learned was a proposition in descriptive geometry involving a definite principle. Since no text contained an explanation of this principle it was *necessary* to resort to the method of a blackboard demonstration.

The Method of Teaching.—In presenting the problem to the students it was first very carefully stated and the given conditions and required results thoroughly explained. Using the given data a demonstration was then presented accompanied by an illustrative figure on the blackboard which was built up line by line as the demonstration proceeded.

After several class periods had elapsed, and ample time for study had been given, an examination upon this principle was given.

As would be expected, some students failed to pass this examination—failed, in fact, to understand the principle which had been the subject of the lecture. These students were then required to work out this principle under supervision until it was thought that they understood it. Following this a second examination was given. Both those who had passed the first examination and those who had failed it were required to take this second examination.

This same process, covering each time the same principle, was repeated for four or five examinations, and with three different groups of students during three different years.

The Result.—The curve, Fig. 1, is a composite. It illustrates the general result for all groups rather than the exact

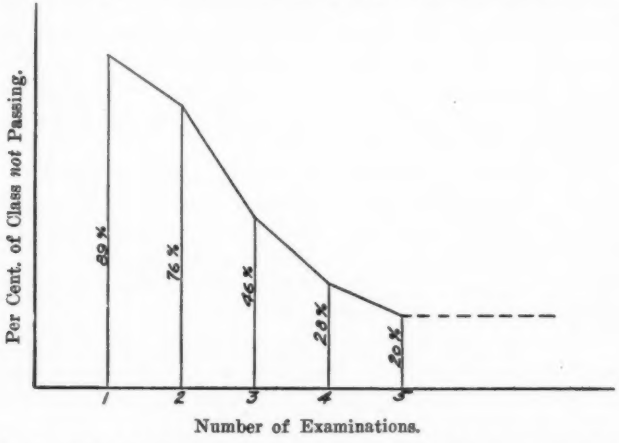

FIG. 1. Result by Lecture Method. Note: Intervals between examinations were seven days.

result of the tests of any one group. It very accurately expresses, however, the results obtained from this method of instruction. Vertical distances represent percentages of the class *not passing* any given examination, horizontal distances represent both the number of opportunities, or examinations, and the time allowed for preparation.

In general, it will be noted that about twenty per cent. of the class never mastered the principle involved, and that it required about four trials before that portion of the class which could master the principle actually did master it.

This, let it be remembered, was the result of the lecture method. Let us now examine the effect of teaching by textbook without the lecture.

The Problem.—At this time a text was adopted for use which contained a complete explanation of this principle which was proving so difficult for students to understand.

The statement of the problem, the given and required data were identical, and the method of explanation in the text was the same as that followed on the blackboard. The only differences between the method of presenting the subject-matter were these—in the text the student was presented with a figure which was complete, on the blackboard the illustrative figure was built up line by line. Otherwise the presentation was the same except that the method varied.

The Method of Teaching.—The problem was assigned as a lesson. No explanation concerning it was given other than that the problem was important and required careful study. Opportunity was given for students to ask questions and to clear up any doubtful points. After sufficient time had elapsed an examination on this problem was given.

As in the first experiment some students failed, a much smaller proportion of the class, however. These were coached and given further opportunity to master the principle, then a second examination was given to all students. This same process was repeated until a total of three examinations had been given.

The Result.—The curve, Fig. 2, is the exact record of what happened in one class. It will be observed at once that those students who could master this problem demonstrated this fact on the first trial, and that those students who could not pass the *first* examination never succeeded in mastering the principle. Other groups of students were tested in a similar manner with similar results. While the curve in Fig. 2 is the exact record of one group it is also a typical record of class performance under this system of instruction.

Conclusions.—The conclusion to be reached from these two experiments is so obvious as to require no exploitation. Briefly stated it is this—the method of presenting facts to students by the lecture system is inferior to the method of presenting facts by the text-book system.

Students are not capable of taking notes, are not able to remember demonstrations without notes, and are not developed mentally to the point of being able to assimilate facts at one hearing.

Given a text in which the matter to be learned is clearly stated, students will devote sufficient time to the study of these

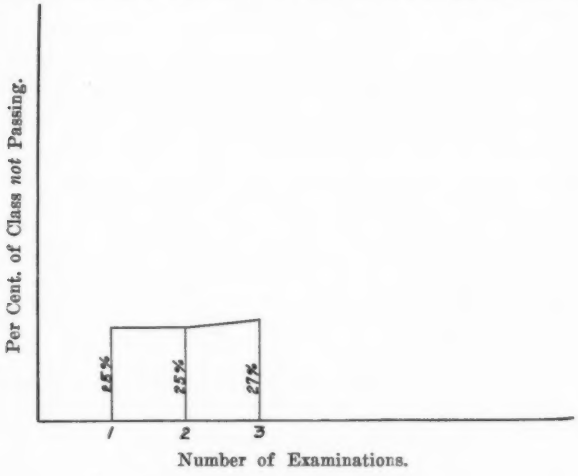

FIG. 2. Result by Text Method.

facts to overcome their individual handicaps in rates of learning. The proof of this is shown in Fig. 2.

After sufficient time for study, a class will demonstrate, if taught by the text-book method, in *one* trial that they have mastered the lesson. It requires from three to five trials to reach the same state of class perfection when the instruction is by the lecture method.

STIRRING UP DRY BONES.

BY JOHN S. CRANDELL,

New York City.

If a business man wishes to introduce a new department into his factory, into his office, or into any branch of his particular industry, he seeks out an expert in that line and turns over the organization of the department to him. That expert must produce results with untrained men; and to produce results he must be able to teach his force. He must be able to teach them thoroughly and well. And to teach them he must know his subject perfectly. If he is not able to do this his men will not respect him, cost of production will be high, the product of his department will not be salable, and he will soon find himself without a position.

Business men know this, and therefore take pains to secure men who are trained and able to handle particular propositions. This is one of the secrets of Big Business.

It is high time that our colleges and universities follow suit. In fact they should have led the way in this direction. Instead, for the most part, they have pursued just the opposite course, so that we have the spectacle of hundreds of instructors attempting to teach subjects of which they have but the slightest knowledge.

At the present time there is a demand for highway engineering courses. Yet how many of the men now teaching the subject, or who will be required to teach it this coming year are thoroughly qualified to do so? Probably not a dozen in the country! For, to properly teach highway engineering a man should travel very extensively, and obtain first-hand information on every phase of the subject, and this the salary of the average teacher does not allow.

The usual procedure is to inform some man who is teaching railroad engineering that he is to teach highway engineering as well, it being taken for granted that the two are very intimately related. Often, far too often, the man teaching railroads has obtained his information, or the most of it, from books, and he knows little of actual railroad work. He is doubly handicapped, then, when he endeavors to teach highway work as well.

How many of those teaching highway engineering have ever put in real hours in bituminous laboratory work, in stone and brick testing laboratory work, and in actual road construction? And of those who have done all this how many can teach?

What has been said applies to nearly every course that is given in a technical school. The writer has seen men put to teaching geodesy who knew nothing about it. Others he has seen teaching structures who never had erected a bridge, or watched one being erected, or worked in a bridge drafting room. Others he has known who, at short notice, have been obliged to teach courses in astronomy whose only qualification for the work was that they could pick out Polaris with some degree of certainty. And so on indefinitely: men teaching hydraulics and sanitation whose life work has been in entirely different fields; young recruits put to teaching all sorts of subjects of which they themselves had but the merest smattering of knowledge; and one instance in particular where a professor of geology had to teach psychology when the funds of the college were low!

Often one can hear young instructors telling how they are just one lesson ahead of the class in some subject. And they seem to think that they are "putting one over" on the students! Have they never listened to the remarks that the students make about them? Do they never remember their own feelings on just such matters in *their* student days? Do they really imagine that they are really "getting away with it?"

When a man is set to teaching something he is not qualified

to teach, the gain is his, and the loss is the students'. A man certainly cannot teach a subject without learning a great deal about it, but while he is learning what he should have known, his students are suffering from his lack of knowledge.

And how bitter are the thoughtful among those students in later life! They feel that they were cheated; that they sat at the feet of men who knew but little more than they did, if as much; that the hours spent were wasted. Nor can these same men praise highly enough those who knew their subjects and really taught them something.

Let us see where the trouble is; let us look at the matter from the viewpoint of the instructor, and from that of his superior officer.

A young man decides that he wants to teach in a college. He is a graduate of a technical school, and he may have had a year or two of practical work in some highly specialized line. He hears of an opening, applies, is interviewed, and is hired. He is given his schedule and finds that he has about 20 hours a week, maximum. He probably has two or three subjects to teach that he vaguely remembers having pursued in his freshman or sophomore years. He starts in and soon finds that he has a great deal of time on his hands, for his 20 hours a week are really only two days' work if the hours were bunched, as they would be in business. By a little application he can keep ahead of his classes so as not to be caught napping. He receives no instruction from his superior how to teach, when a few practical hints from an experienced teacher might go a long way toward making a better instructor of him. He is largely left to his own devices. For the not over-ambitious average man this spells rust and decay. The easy life, the seeming lack of responsibility, and the frequent and long vacations all tend to cause a young man to do as little as he can. Teaching is often either a lazy man's job, or a stepping stone; in both cases the college suffers. At this period of his life the young man cannot see graduates returning, laughing at him, or openly sneering at him; for nowhere is the saying "As ye

sow" as true as in teaching college men. He does learn considerable of the subjects he is teaching, but it is mostly book knowledge. In time, if he sticks, he may turn out to be a fair teacher of book-taught information. And then again there may be an irate committee of students appear before the Dean or the President and demand the removal of the young man as an incompetent!

During summer vacation he "rests."

The head of department in hiring new men has great difficulty in obtaining suitable material. He has only a small amount of money at his disposal for salaries, and therefore cannot hope to attract big men; he may be pressed for time, some one has resigned just before the term opens and he has to take the best that offers itself; he cannot tell a man's teaching ability at sight; he will give the man only elementary subjects, anyway, and somehow he will get by. And oftentimes the head of department knows as little about practical things as the man whom he hires. So he "takes a chance" on the young man "taking a chance," and the students get their chance at "taking a chance."

A man in the ordinary course of business life works at least eight hours a day, or 44 hours a week. If he had to work but twelve or fourteen hours a week, as many of the members of our faculties do, he would think the millennium had come. As a matter of fact many of our successful business men work nearer 18 hours a day than 8.

Now the remedy. Double up the number of working hours, double the salaries, and cut the faculty in half. Engage men who are thoroughly versed in two or three specialties; men who are experts in the subjects they teach; keep them teaching those specialties. This is an age of specialties. Require, as part of their contract, that these men spend two months in the summer in actual work on one of their specialties, changing the work each summer. This will leave a month's vacation, or two weeks more than most men get, to say nothing of the numerous vacations during the year. Engage no one who has

had no practical experience in the technical work he is to teach. Turn the drudgery of teaching, *i. e.*, correcting papers, laboratory preparation, and the like, over to men hired for that purpose, as far as possible. These men may be considered as apprentices in teaching, who, after they have had practical experience, may become regular members of the faculty. Men new to teaching should be given some of the fundamentals of pedagogy. Not all the bosh that is fed to normal-school students, but a few well-chosen principles of teaching. A natural born teacher needs no more: others should not be teaching.

With a good salary a good man can be hired who will not mind teaching 35 or 40 hours a week any more than he minds working that length of time at the practice of his profession outside the college walls. With such men as teachers the product of our institutions will improve immensely, and students will find it an inspiration instead of a drudgery to go to college.

FURTHER CORRELATION IN ELECTRICAL ENGINEERING.

BY C. FRANCIS HARDING,

Professor of Electrical Engineering, Purdue University.

"Intensive training" is the by-word of the day during this military crisis. Many experimental changes in the administration of university work, undertaken during this period, will no doubt prove of such value in times of peace as to find a permanent place in the curricula of technical institutions. One change in the school of electrical engineering at Purdue University seems to meet such a need as judged by experience to date.

It has been felt for a long time that most efficient university instruction is impossible with a student class schedule involving a large number of varied subjects, each of which brings a student before a given instructor but three times per week or less. To use electrical phraseology, why not administer more intensive courses in series rather than short hour courses in parallel?

In order to give such a principle a fair trial and to correlate further the theoretical study of electrical machinery with the laboratory tests upon the very apparatus being studied in class at any one time, the schedule of subjects in the curriculum was completely rearranged during the present year. The difficulty of such a plan, especially with large classes, results from the necessity of having on hand several sets of machines of similar type in order that several groups of students may be testing one type of machine at the same time. Experience has shown, however, that even in cases where the number of students in a squad must be increased to six or eight or, in extreme cases, where a demonstration test must be provided for

an entire section of twenty men with different students taking individual readings, the benefits of absolute correlation with class-room work more than outweigh any such handicaps of administration.

Such a plan may offer less opportunity for formal laboratory reports, many of the results and characteristic curves being worked out during a demonstration period. Often the ways and means of testing a given machine may occupy the preceding class-room period while the results of the test form the subject-matter under discussion at the subsequent recitation. The desired training in writing complete engineering test reports is provided for in the second semester of the senior year in a laboratory test course undertaken after the combined laboratory and theoretical course on electrical machinery has been completed.

During the past semester more ground was covered in a more thorough manner with a course consisting of five hours per week recitation and three hours laboratory, all in charge of the same instructor and carrying a single grade, than has been accomplished in past years with a three-hour course with disassociated laboratory work continuing for a full year. In the junior year a course involving six hours per week was possible.

These results cannot be attributed to any endeavor on the part of either instructors or students to anticipate a possible February commencement, for such was at no time contemplated. With the engineering reserve ruling in operation in response to a desire for a complete technical training on the part of prospective military officers, there seems to be less occasion for the early commencement than seemed to be the case at first.

As the demands of the year have developed, it is particularly fortunate that this plan was adopted. Seniors are now able to undertake the special courses prescribed by the Signal Corps, U. S. Army, during the second semester with no curtailment of other than elective subjects. Ninety per cent. of the

seniors in electrical engineering are availing themselves of the opportunity of specialized training in this branch of military work for which the electrical engineering student seems to be particularly well qualified.

The courses in electrical machinery for the non-electrical engineers have undergone a similar change and since these involve relatively less time, the results are fully as favorable. Let a graduate engineer attempt to focus his attention upon ten or twelve different engineering and economic problems requiring intensive study and concentration, and further assume that he is obliged every fifty minutes to stop where he is and attack another problem having no connection with the former. He will at once appreciate by way of contrast, the value of the series over the parallel schedule of subjects in the university curriculum.

THE ENGINEERS' SYSTEM OF MECHANICAL UNITS.

BY WM. S. FRANKLIN AND BARRY MACNUTT.

The essential difficulties which must be met and overcome in the teaching of elementary mechanics are very great, and all difficulties which grow out of non-essentials should be completely eliminated. It is therefore quite intolerable that any disagreements as to terminology and units should now be left outstanding.

The chief obstacles to agreement in the past have been (1) an unreasonable and mistaken contempt on the part of the physicist for the engineers' system of units, (2), the fact that a particular engineer or engineering teacher is interested only in a partial use of the system, and (3) a failure among many teachers, of physics and of engineering, to understand that precision of definition and precision of thinking is not the same thing and in no way dependent upon or mixed up with numerical precision.

We confess that we have been guilty of the above-mentioned contempt, unreasonably and mistakenly, and we trust that this confession on our part may qualify us to speak of the remaining obstacles (2) and (3) without offense.

The term *mass* means quantity of material as measured by a balance scale, and it is properly expressed in grams or pounds. In commerce, however, we speak of the *weight* of a batch of sugar or coal as *weighed* by a balance scale, and the word *weight* so used means exactly the same thing as *mass*.

Technically the *weight* of a body means *the force with which the earth pulls on the body*, and it may be properly expressed in dynes or poundals. The pull of the earth on a one-pound body in London is a definite force, for many purposes it is the most convenient unit of force, and it is

called the "pound." The weight of a body, that is to say, the earth-pull on a body may be properly expressed in "pounds" *but the coal man's scales do not determine the weight of a body in "pounds."*

One "pound" of force gives an acceleration of 32.174 feet per second per second to a mass of one pound, so that according to Newton's second law, one "pound" of force will give an acceleration of one foot per second per second to 32.174 pounds of material (one *slug* of material) Therefore if force is expressed in "pounds," mass in slugs and acceleration in feet per second per second the simple form of the equation $F = ma$ can be used.

To reduce pounds of coal as measured by a balance scale to slugs, divide by 32.174 (a pure number, *not* an acceleration). The weight W of a body (the force with which the earth pulls a body) is of course equal to mg, so that the mass of the body m equals W/g. Thus the actual local weight of a body *in London "pounds"* divided by the local value of g gives the mass of the body in slugs*; but when your coal man sends you a bill for what he calls a certain *"weight"* of coal, say 2,000 pounds, do not divide this kind of "weight" by b to get mass!

The system of mechanical units which involves the "pound" as a unit of force is very widely and properly used, and every teacher of elementary mechanics should use this system of units unhesitatingly. We call the system the *foot-slug-second system* in order to differentiate it sharply from the *foot-pound-second system.* There is no objection to the precise use

* A perplexing mix-up of dimensions is involved in the double meaning of the word pound. Out of respect for etymology we may postulate identical dimensions to the pound of sugar and the "pound" of push or pull, or we may postulate identical dimensions to pounds of sugar or slugs of sugar. We prefer the second postulate, and, in accordance with this postulate, one must divide pounds of sugar by 33.174 (a numeric) to get slugs of sugar, and one must divide the local weight of a body in London "pounds" by the local acceleration of gravity (a denominate number) to get mass in slugs. From this point of view the "pound" of force has the same dimensions as the poundal of force.

of the foot-slug-second system except on the ridiculous assumption that the primary business of the teacher is to promote the metric system; but it is improper for anyone to agree to use the word *weight* for the force with which the earth pulls on a body and then carelessly revert to the usage of the grocer and the coal man.

The weight of a body in London in "pounds" is, of course, equal to its mass in pounds, and it has, more than once, been proposed to call the weight of a body in London its *standard weight* and use the term *standard weight* instead of *mass;* but there are two objections to this, namely, (*a*) the term mass is almost universally recognized by physicists and chemists, and (*b*) the mass of a given body is independent* of time and place, it has to do only with an invariant* relation between the given body and the standard kilogram (a piece of metal), and extraneous and confusing ideas would be introduced by the use of the term *standard weight* because this term implies location and a relationship between the given body and the earth. How awkward it would be, for example, to be obliged always to speak and think of the distance d between two points (x, y, z) and (x', y', z') as $[(x-x')^2 + (y-y')^2 + (z-z')^2]^{\frac{1}{2}}$. This is an invariant and the most useful name or symbol for it is a name or symbol which carries no redundant suggestion as to particular axes of reference, *and this would be true even if we had always to make use of a particular set of reference axes in the measurement of d.*

The units of any system can be used in any equation in mechanics (including hydrostatics and hydraulics) if the equation is in its simple generalized form.

Example 1. $F = ma$, where F is in "pounds," m in slugs and a in feet per second per second; or where F is in poundals, m in pounds and a in feet per second per second.

Exmple 2. $W = 1/2\ mv^2$, where the kinetic energy W is in foot-"pounds," m is in slugs and v in feet per second; or

* No consideration is here given to variations of mass as recognized in the recent developments of the principle of relativity.

where W is in foot-poundals, m in pounds and v in feet per second.

Example 3. $T = Ka$, where a is the angular acceleration of a wheel in radians per second per second, K is the moment of inertia of the wheel in slug-feet^2 (or in pound-feet^2) and T is the accelerating torque in "pound"-feet (or in poundal-feet).

Example 4. In testing a piece of steel the weight of 10,000 pounds of material is applied to the piece. The force is 10,000 g poundals or $(10{,}000 \div 32.174)\ g$ "pounds," where g is the local acceleration of gravity. *For all practical purposes the difference between* $(10{,}000 \div 32.174)g$ *and* 10,000 *is entirely negligible in this kind of a test, and therefore many engineering teachers are led to think that it is mere affectation to insist on a precise definition of the "pound" of force as the pull of the earth on a one-pound body in London.*

Example 5. $p = ldg$ where p is the pressure in "pounds" per square foot (or poundals per square foot) at a point l feet beneath the surface of a liquid of which the density is d slugs per cubic foot (or pounds per cubic foot) at a place where the acceleration of gravity is g feet per second per second.

Let us repeat. There is no generalized equation in mechanics (including hydrostatics and hydraulics) in which f. s. s. units may not be used, but the coal man's pounds must not be divided by the local value of g to give mass in slugs. The expression $W = 1/2g.mv^2$ for the kinetic energy in foot-"pounds" of a moving body of which the mass is m pounds and the velocity is v feet per second is incorrect and misleading. Of course, ignoring dimensions of g, it is accurate enough for all practical purposes; yet, but the most important practical thing in this world is clear and precise thinking, and for purposes of thinking the equation $W = 1/2g\ mv^2$ is simply out of the question.

It always amuses us to hear an engineering teacher express contempt for the poundal as a unit of force, and we use the

poundal chiefly as a name for a step in an argument. It is better to name it than to refrain from naming it, thereby pretending not to use it. Everyone who expresses mass in pounds does use the poundal as a unit of force, and every English-speaking person expresses mass in pounds when he buys sugar or coal. If a man steals sugar no accounting is necessary, at least no book-keeping is necessary, and only such men among English-speaking people can honestly claim not to use the poundal as a unit of force. The question would appear therefore to be a question of honesty versus dishonesty, but it is not quite as bad as that, for the second horn of the dilemma may be unconscious dishonesty or sophistry, and this unconscious dishonesty is carried to the limit by a recent writer who speaks of the coal man's unit of mass as scholastic.*

Several years ago one of us pointed out the most troublesome fallacy in elementary mechanics in a discussion of Professor Maurer's S. P. E. E. report on mechanics, namely, the agreement to use the word *weight* for the gravity pull of the earth on a body and the subsequent reversion of most of our engineers and engineering teachers to the usage of the grocer and the coal man! If agreements are made let them be lived up to.

* Professor E. V. Huntington, of Harvard University. See *American Mathematical Monthly*, January, 1917, page 16.

PRELIMINARY REPORT OF COMMITTEE NO. 12, ENGLISH.

In continuation of the committee's work for this year, the following questionnaire was sent to teachers of English in one hundred technical colleges in the United States:

TO THOSE WHO ARE INTERESTED IN THE TEACHING OF ENGLISH TO ENGINEERING STUDENTS.

Committee No. 12, Society for the Promotion of Engineering Education, has received instructions to continue the study of the present status of instruction in English for engineering students.

In carrying on its work of investigation, the committee seeks the coöperation of all who are interested in this phase of the engineering student's training. It is believed that the time has come for a new and a definite statement of the place English should have in the general scheme of engineering education. During the present year, by reason of their new relation to the War Department, engineering colleges have been given increased responsibility as well as added prestige. Many of them have already begun to scrutinize their curricula and to weigh the respective claims of the various subjects now scheduled. The forthcoming report of the Carnegie Foundation for the Advancement of Teaching will serve both as a guide and as a stimulus to further self-analysis, and will evoke a general discussion of the relation of each subject to an entire program of professional training for engineers. The committee feels that teachers of English, along with teachers of other subjects, will be benefited by this challenge for a restatement of their point of view, and for a vindication of the claims of their particular branch of study.

As a modification of the usual questionnaire, the committee has adopted a plan, which, it is hoped, will elicit a more com-

plete expression of experience and opinion than is possible in a tabular arrangement of questions and answers. Recipients of this letter are requested to indicate on the enclosed duplicate, pages 214 and 215 from the Proceedings of the Society for 1917, the following information.

PART I.

1. *English as a guarantee against illiteracy among college graduates.*

   a. Typist English: review of elementary grammatical and mechanical forms, to make up for inadequate preparation of entering students.

   b. A constant check upon the writing of students during their course, in order to cultivate habitual correctness of form.

   c. Heavy penalties for mistakes, and refusal of degrees to incorrigible illiterates.

   d. Reading and study of literature, especially the classics, chiefly for the sake of familiarity with what educated people are expected to know.

   (It will be noted that this division is intended to protect the reputation of the institution as much as to aid the student. It will also be evident that (*b*) and (*c*) require the coöperation of technical departments.)

2. *English as training in thinking.*

   a. Rigorous drill in exposition, especially in definition and analysis.

   b. Briefing and writing of argumentative compositions.

   c. Developing the student's constructive imagination.

   (See Professor C. A. Smith's recommendations.)

3. *English as a tool for use in technical work during and after the college course.*

   a. Note taking.

   b. Writing of reports.

   c. Writing of technical papers for student societies.

   d. Writing and criticism of technical articles.

e. Writing of business letters.

f. Oral presentation of technical matter, including both prepared and impromptu speeches.

4. *English as a groundwork for effective expression.*

a. Reading and study of masterpieces of English literature, in order that their literary quality and technical excellence may influence the student's own style.

5. *English as a link between the professional and the human interests of the student.*

a. Reading and writing of essays interpreting the work of the engineer and explaining the larger meaning of his industrial environment.

b. Reading and criticism of contemporary fiction and poetry which express the spirit of the age.

6. *English as a cultural and recreational escape from the monotonous literalism of vocational study.*

a. Literature studied as literature, with emphasis on its æsthetic values.

b. Reading for the sake of enjoyment, diversion, appreciation. (Far from attempting to show the connection between literature and the engineer's vocation, this type of instruction demands that he forget his profession entirely for the time being and lose himself in a totally different atmosphere.)

a. What aims of English teaching, if any, do you omit from the list given on these pages?

b. What aims, if any, do you add to this list?

c. What is the approximate percentage of time allotted to each division?

It is assumed that replies to these questions will be based on conditions as they actually exist, and not on an improved or ideal arrangement toward which a given institution may be working. For example, an instructor may feel—and rightly—that aim No. 1, dealing as it does with elementary English, should be taken for granted as a part of the student's entrance requirements, although, in actual practice, this division may require from ten to twenty per cent. of the total time given to

English. At the same time, the committee wishes to include suggestions for improvement, both in the distribution and in the methods of presenting the various phases of English instruction. In addition, therefore, to the above brief statement of what is being done, you are invited to give a fuller statement of your experience, and an outline of your recommendation on as many as possible of the following subjects, and on kindred topics concerning which you have something to say.

PART II.

(Please use a separate sheet of paper for each topic.)

1. A Well-Balanced Course in English for Engineering Students.
2. Elective Courses in the Engineering College.
3. Oral English in the Engineering College.
4. Making Correct English a Habit.
5. English as Training in Thinking.
6. Developing the Engineering Student's Constructive Imagination, through Instruction in English.
7. Technical Applications of English for Engineering Students.
8. Literary Composition in the Engineering College.
9. English as a Study of the Human Side of the Engineers' Profession.
10. Literature as a Reflection of the Time-Spirit in Science and in Industry.
11. "Mere Literature" in the Engineering College.
12. Entrance Requirements in English for Engineering Students.

Realizing the extra labors which most instructors are now performing in connection with the war, the committee will be all the more grateful for as full and specific a discussion of one or more of these topics as you find possible. Kindly forward replies to Part I to reach the chairman not later than May first. The committee will be glad to have an early con-

tribution dealing with some phases of Part II and to receive further suggestions later at your convenience.

Signed,

COMMITTEE.

Complete figures on the referendum in Part I are not available at the time when this manuscript is sent to the printer. The following data from a tabulation of the first twelve reports may be of interest, as suggesting an average proportion of time given to the different aims in the teaching of English to engineering students.

1. *English as a guarantee against illiteracy among college graduates.* (23.3 per cent.)

2. *English as training in thinking.* (25.5 per cent. Omitted by one.)

3. *English as a tool for use in technical work during and after the college course.* (23.3 per cent.)

4. *English as a groundwork for effective expression.* (10 per cent. Omitted by three.)

5. *English as a link between the professional and the human interests of the student.* (11.6 per cent.)

6. *English as a cultural and recreational escape from the monotonous literalism of vocational study.* (5 per cent. Omitted by six.)

An interesting addition to No. 6 made by one institution is a *cultural course in general information.* This course, the material of which in a number of other colleges is treated under No. 2, is outlined as follows:

Exposition of an idea: Popular government.
Criticism of the permanent peace program.
Emancipation of women.
The meaning of Christianity.
Democracy and education.
The meaning of "Social Justice."
Evolution.
The idea of progress.
Ethics.
Culture.

This is one of several suggestions that the course in English shall acquaint the student with a definite body of non-technical information and shall stimulate his thinking on political, economic, social, æsthetic, and ethical subjects. Indeed, the most conspicuous modification of the "standard" course in English just now is in this direction. The theory underlying the change seems to be, first, that along with his technical studies the student should acquire a maturity of understanding in the larger human interests outside his special field; and second, that direct encouragement is needed in order to develop a proper appreciation of these problems. The responsibility and the opportunity of presenting this material falls to the instructor in English, partly because it belongs to no one else, and partly, also, because he is in the best position to arouse interest in human issues and to measure student reactions to them. Thought-provoking material of this kind commends itself especially to the teacher of composition, since it induces natural and spontaneous writing.

Most of the specific data gathered by the committee this year will doubtless be chiefly interesting to teachers of English. The committee hopes to present in a forthcoming report a digest of concrete recommendations which will be directly useful in the teaching of English to engineering students. For technical men in general, the questions of aims, methods, and emphasis outlined in the first part of the questionnaire will, it is believed, prove more interesting and more suitable for discussion at a meeting of the Society.

Respectfully submitted,

C. W. PARK, *Chairman*, Univ. of Cincinnati.
FRANK AYDELOTTE, Mass. Inst. of Technology.
CHARLES ALPHONSO SMITH, Annapolis Naval Acad.
C. F. PARK, Mass. Inst. of Technology.
J. R. NELSON, Univ. of Michigan.
PHILIP B. MCDONALD, Univ. of Colorado.

REPORT OF COMMITTEE NO. 14, ECONOMICS.

The Committee on Economics has had no meetings, having found it more feasible to consider the matters assigned to it by means of correspondence. Owing to the press of other duties, Professor R. H. Fernald found it impracticable to serve on the committee, tendering his resignation immediately after his appointment, and no one was appointed to fill his place.

The Society's instructions to the committee were, "To continue the work of the previous committee." The previous committee collected certain statistics concerning the present status of economics courses in engineering schools and recommended that the succeeding committee "prepare a definite scope and content of courses" based on the following topics:

1. A preliminary study in commercial geography and industrial history.
2. Fundamental course in the principles of economics.
3. Application of these principles to engineering.
4. Lessons upon special application in detail engineering work.

The present committee has made a further study of the existing status of economics courses in technical schools, which study is summarized for the three principal branches of engineering in Tables I and II.

From these data, it appears that about half of the technical schools of the country, taking these forty-two prominent ones as typical, require economics of civil engineering students, and two thirds require it of mechanical and electrical engineering students. Twelve credit hours required of all students is the maximum, and that amount is required at only one institution. A three-credit-hour course seems to be the prevailing custom. Economics is elective or optional in most of those institutions in the above group with zero hours indicated as required, and in a few instances it may be offered for

more than the number of required hours. As to the nature of the course, it appears that general principles of economics prevails.

TABLE I.

CHARACTER OF COURSES IN ECONOMICS REQUIRED IN FORTY-TWO LEADING TECHNICAL SCHOOLS.

Nature of Course.	Schools in which Course is Required.					
	Civil.		Mechanical.		Electrical.	
	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.
General economics	21	50	21	50	21	50
Political science	2	4	3	6	3	7
Sociology	1	2	1	2	1	2
Industrial history	1	2	1	2	1	2
Business and finance	2	4	4	9	5	12
Special engineering economics.	3	7	5	12	3	7
No course required	18	43	13	31	14	33

TABLE II.

NUMBER CREDIT HOURS REQUIRED IN ECONOMICS COURSE.

Credit Hours Required.			Number of Schools with this Requirement.
CE.	ME.	EE.	
12	12	12	1
0	9	6	1
6	6	6	3
5	5	5	3
4	4	4	1
3	3	3	8
2	2	2	6

In previous discussions of the subject assigned to this committee, a misapprehension has arisen apparently from lack of definition of terms, and particularly from the confusion of two distinct ideas, which are, indeed, the essence of the matter under discussion, namely, "*economics*" and "*economy of construction.*" The habit of some writers of putting these two subjects together under the term "economics" leads to a lack of clarity of purpose. The committee understands the term economics to mean "The science of wealth" and to deal with matters pertaining to the consumption, production, exchange

and distribution of the world's wealth as a more or less abstract social science. Economy of construction, on the other hand, should cover those principles of design and construction which accomplish desired results with the minimum expenditure of money, all factors being considered, and is founded primarily upon unit costs, maintenance and life of structures and cost of operation. There does not appear any sufficient reason why these two matters which are so essentially distinct in character should be grouped together in their administration. The four topics presented by the previous committee and mentioned above include two, the first and second, that fall under the term *economics,* the other two pertain more particularly to *economy of construction,* and the present committee has so grouped them.

From the information at hand and after as complete an interchange of views as the limitations of correspondence would permit, the present committee has attempted to formulate recommendations concerning (*a*) the amount of time to be devoted to economics, (*b*) the nature of the course and (*c*) the mode of administration.

The committee recommends that an outline course on economics but no more be required of all engineering students. Engineering has chiefly an economic aspect, that is, it has to do with the production, exchange and distribution of wealth, and the student should become familiar with those general factors which are the framework of society's economic organization and should be led to see how engineering operations are related to them. He should understand that an engineer possesses a training that has economic value and that he will be able to "market his wares" only as he comprehends the economic and commercial organization of society from both the theoretical and the practical viewpoints.

As to the proper amount of time to be devoted to economics in engineering courses, the committee, after considering the factors which it believes should control the arrangement of college curricula as well as taking into account the prevailing

practice, recommends that the amount of time devoted to the formal study of economics be not more than three semester credit hours. The committee is of the opinion that this amount of time will give the student a sufficient outline of the scope, character and limitations of the subject, while, on the other hand, more than that time cannot be devoted to the subject advantageously for the following reasons. Economics is not an "exact science" even with a liberal interpretation of that term, and for that reason largely, engineering students accustomed to studying mathematics, physics, chemistry, mechanics, etc., fail to get the economist's point of view and mode of reasoning and consequently derive very little benefit from an extensive study of economics as a disciplinary exercise. In other words, most of the fundamental propositions of economics are not capable of rigorous and irrefragable demonstration, consequently an extended study of the subject as an exercise in logic may tend toward confusion for the technical student, who is accustomed to less equivocal modes of thinking. The fundamentals of the subject that can be learned in a three-hour course as so much information are sufficient to form a skeleton or framework to which the student can refer his subsequent general reading of a related character. Moreover, owing to the immaturity of the average student's business experience, he has little background for a study of commerce, and for this reason, also, a more extensive study of economics is not considered profitable for engineering students.

With regard to the character of the course, the committee recommends that the subject-matter be similar to the treatment in any standard text on "economics" or "political economy," with frequent illustrations from the actual facts of commercial geography and industrial history, with perhaps a few special lectures on these latter subjects near the close of the course, with a view to calling attention to their more prominent features. Not infrequently time in the lecture room or class room is not utilized to the best advantage because trivial and inconsequential illustrations are employed when illuminating illus-

trations are available from commercial geography and industrial history, and it is urged that advantage be taken of such whenever possible.

Special subjects in the economics group, such as accounting, labor problems, public and corporation finance, taxation, money and banking, and others, while possessing much value as information courses, do not seem to deserve a place in the engineering curriculum owing to the already crowded condition of the latter and also because an intelligent technical graduate can read books on any of these subjects understandingly without the aid of an instructor.

It is further recommended that matters pertaining to *economy of construction* be taught in connection with the separate courses to which they are related, the instruction being adapted to the nature of the particular subject under consideration, rather than offer a separate course in economy of construction with a view to making it cover its various phases. However, special lectures and assignments on the economy of construction should be given from time to time. It is believed that aside from a few elementary mathematical relationships between fixed charges, maintenance and operation, and annual costs, the principles involved are not sufficiently general in their application to warrant a separate course in the present crowded condition of the curriculum.

The committee finally recommends that special attention be given to the mode of administering the course in economics for engineering students. In many institutions there seems to be an apathy on the part of the latter with regard to this subject, due perhaps to one or more of several reasons, such as: the sentiment that it is a liberal arts subject and therefore of no value to an engineer; it is not directly applicable in problems of design or construction; economics not being an "exact science" is so different from the student's usual mode of thought that he finds himself in a strange realm; due perhaps to this last condition, there may arise at times a lack of sympathy between the instructor and the student. Whatever may be the

cause, this apathetic attitude should be carefully guarded against.

The committee is of the opinion that the subject of economics should be taught to technical students by a professor of economics having a broad education and experience in corporation business. Neither an immature instructor on the one hand nor a preoccupied head of a department on the other should attempt to instruct engineering students, but a man to whom the subject is alive and possesses a vital connection with the commercial world should be placed in charge, otherwise the natural interest of the student will be stifled.

The problem method of instruction has much to commend it as a method of teaching engineering students, due chiefly to the usual mode of preparing their lessons, viz.: by reading a text and solving problems based on the principles expounded therein. A few such problems assigned daily with written solutions prepared in detail required would add interest as well as value to the course.

Summarizing, the committee recommends that a three-semester-credit-hour course in general principles of economics be required of all engineering students, such course to constitute the entire formal study of this subject in four-year courses; that *economy of construction* be taught in conjunction with the separate courses in design and construction, and that special attention be given to the mode of instruction with a view to accomplishing the most definite results possible in the time allotted to the subject.

Respectfully submitted,

A. B. McDaniel,
W. G. Raymond,
G. F. Swain,
C. C. Williams,
Chairman.

REPORT OF COMMITTEE NUMBER 15, COMMITTEE ON CIVIL ENGINEERING.

Assigned subject "Methods and Details of Teaching Structural Designs."

The committee has planned for a progress report this year and a formal one in 1919. The progress report consists of four papers, prepared by members of the committee as follows:

1. The *objects* of the structural courses.
2. The *subject matter* necessary to carry out these objects.
3. The *manner of presentation* of the subject matter.
4. The *training of instructors* to carry this out in an effective manner.

Three of these papers are published in this issue of the BULLETIN with the hope that the discussion which will follow at the Convention and in future issues of the BULLETIN may serve as a basis for a later report.

Submitted by

A. H. FULLER, *Chairman,*
H. J. BURT,
C. T. MORRIS,
W. C. HUNTINGTON,
J. HAMMOND SMITH.

THE OBJECTS OF THE STRUCTURAL COURSES.

BY HENRY J. BURT,

Structural Engineer.

In this land, where education is a public function, the welfare of the commonwealth has first claim to consideration in the objects to be attained. The selfish interests of the student must be subordinate. If success be considered works accom-

plished rather than financial gain, the interest of the state and the interest of the student may be considered identical. The man should be trained to be a constructor, rather than a contractor; to be an economist of materials and labor rather than an economist of money; to conserve or make useful material resources rather than to consume them. These considerations are very general but should be in mind while specifying the training to be given in structural engineering.

Structural engineering is here considered as a part of the broad profession of civil engineering. Although its importance is growing rapidly in relation to the other branches of civil engineering, it has not yet become recognized as a distinct and separate profession. It follows that the structural courses must be a part of any complete curriculum of civil engineering. So far as the writer is informed, it is so recognized in all engineering colleges.

A broad definition of structural engineering makes it include all static structures whose designs are based on scientific principles and mathematical calculations. It involves the relation of load to strength, or stress to strain. There is practically no engineering design that does not involve the principles and calculations of structural engineering. This being so, it is evident that structural courses should form an important part in the study of civil engineering.

The proportion of the time which should be devoted to this subject is not easy to determine. Perhaps the minimum that should be considered is that required for the study of mechanics of materials, physical properties of materials, and static stresses. At the other extreme would be the time required in curricula when electives are allowed and the student chooses subjects in structural design as his major courses.

The purpose of most students in engineering is to prepare for the practice of the profession as a means of livelihood. If left to their own guidance, they would likely select the subjects that promise the earliest results, *i. e.*, get them into remunerative employment at the earliest practicable date.

This would lead to the study of the practice of engineering rather than the science on which that practice is based. In a few years the man would find that he was practising the art of engineering rather than the science; that he had become an artisan rather than a professional engineer.

Such a result as described above does not represent the best development of the student, so he must be guided into a better channel. He is entitled to such training that he can secure employment in engineering work, but he is not entitled, nor is it to his interest, to be so trained that he can secure an advanced position in practical work, but be lacking in the foundations from which he can build a professional rather than a craftsman's career.

In spite of good resolutions made at the time of graduation, this natural tendency is to neglect scientific studies. Very few young engineers after graduation give any time to advancing their knowledge of the theory of engineering, except when forced to do so by the problems confronting them. The less they know of scientific principles, the less likely they are to pursue the study of them after leaving school.

Recognizing the inability of the student to be his own guide during college days, and recognizing his tendency to neglect scientific study after graduation, it devolves on the teachers not only to prescribe the studies to be pursued during the college period, but to so train the student that he will continue in a progressive channel—all this to the end of securing the best ultimate result rather than early but limited success.

The foregoing discussion indicates the desired preponderance of training in the science of design. The purpose of this training is twofold: (*a*) To store in the brain the fundamental principles involved so that they will always be ready for reference. This should be done as thoroughly as the implanting of numbers and letters is done in childhood. (*b*) To develop in the mind the powers of analysis, synthesis, observation, imagination and logic, so that the man will always be a student.

Some work in the art of design is necessary to illustrate the principles involved. It should be done more with this purpose than for the purpose of training a craftsman. The latter feature cannot be wholly disregarded for the man must be equipped with enough practical skill to make him useful and enable him to start in the practice of his profession. But he must depend on his experience after leaving college to assemble in his storehouse the information, and to acquire by practice the skill that will ultimately make him a success in his profession.

SUBJECT MATTER.

BY C. T. MORRIS,

Professor of Structural Engineering, The Ohio State University.

In the opinion of the writer, the major portion of the work in a civil engineering course should be of a fundamental character and required of all civil engineering students.

As a person grows older, the necessity for a broad training in cultural subjects as well as the sciences impresses itself upon one. It should be the purpose of a college course to prepare one to meet the responsibilities of life and the business world, and to make, above all, good citizens who can take places of responsibility and leadership in their communities.

In the usual four-year course there remains little time for specialization after the necessary fundamental sciences have been taken, and it is the opinion of the writer that the great majority of college students in their third and fourth years are not mature enough to intelligently select the special branch of civil engineering into which it is best for them to enter. In fact the great majority of graduates embrace the most promising opportunity which presents itself after graduation and usually remain in the special line upon which they first enter. This fact makes it desirable that all should have the foundation upon which may be based a career in either municipal, railway or structural engineering.

Some selection of studies should be allowed in the fourth year of the course, but probably not to exceed 8 to 12 credit hours.

The fundamentals required of all civil engineering students should include the following:

Language, including English,
Mathematics through the calculus,
Chemistry,
Physics,
Engineering drawing, including descriptive geometry,
Surveying—land, railroad, and topographic.
Geology,
Mechanics—statics, strength of materials, kinetics and hydraulics,
Materials of engineering, including testing of materials,
Steam, hydraulic and electric power, general course,
Astronomy and geodesy,
Sanitary engineering and water supply, general course,
Timber construction,
Roads and pavements,
Stresses and structural design, general course,
Concrete and reinforced concrete,
Masonry construction,
Economics of engineering,
Contracts and specifications.

After these courses have been given the necessary space in a four-year course, it is seen that very little time remains for specialization, not more than 8 to 12 hours at the most. In these 8 to 12 hours, the student should be allowed to elect any one of several groups of studies along the lines of municipal and sanitary engineering, railroad engineering, or structural engineering.

The structural engineering group should include courses in advanced bridge design, tall building construction, and the principles governing the calculation of statically indeterminate stresses and secondary stresses.

Even if more time than is here indicated is devoted to structural engineering, an effort should *not* be made to turn out finished draftsmen or detailers. The technique of draftsmanship and detailing can be acquired in a few months in any structural drafting room, and if the fundamentals of the subject have been mastered in college the ultimate value of the man will be greatly increased.

Neatness and accuracy, in English, arithmetic, and drawing should be insisted upon during the entire course. Frequent individual problems should be assigned and the solutions required handed in in ink. These should be carefully checked over and errors indicated, as half of the instructional value of the problem is lost if the work is not done independently and the mistakes found and corrected.

Inspection trips to structures in the vicinity should be made and examples of good and bad design pointed out. In this way, as in no other, can methods of construction be taught. The average student has very little conception of these matters and even photographs will not adequately serve. Also if possible, an inspection trip should be made to a plant where structural steel work is fabricated, in order to give the student a general idea of the methods of manufacture.

And finally, the fact should be impressed upon the student that when he graduates he has only completed the first stage of his education. His study and investigation along his chosen line should continue if he expects to keep pace with, and take advantage of the opportunities for advancement which will be constantly offered to those qualified for them.

A brief outline of the structural work given in the civil engineering course at the Ohio State University will serve to illustrate the content of the subjects listed above.

Stresses and Structural Design is required of all civil engineering students except those specializing in municipal and sanitary work. Four recitations or lectures per week for two semesters are required.

In teaching this course an effort is made to review briefly

the principles of mechanics because it has been found that no matter how thorough the training in mechanics has been, the students require some review in order to intelligently grasp the application to structural design. After this brief review of the principles of statics, the graphic and algebraic solution of the stresses in roof and bridge trusses is taken up, followed by the method of coefficients for trusses with parallel chords. The analysis of the stresses in trusses with subpanels and with curved chords is also taken up. Then the wheel load analysis is given for trusses with parallel chords and the methods of calculating stresses up to wind and centrifugal force for bridges with curved track are given. This finishes the course in stresses but it is seldom that all of it can be completed before the end of the first semester and usually part of it has to be taken up in the first part of the senior year.

The work in bridge design commences with the design of beams and plate girders, followed by the design of the main members of truss bridges. Then the design of the details is taken up, commencing with riveting, net sections, pins, etc.

Throughout the course individual problems are given and required to be handed in in ink. Considerable time has been required in developing these individual class problems but I believe that the results fully justify the effort. No matter how conscientious the student may be, if all of the members of the class are working with the same problem, a comparison of results is bound to occur and some of the men will not obtain the benefit that is obtained by the solution of individual problems.

We do not spend a great deal of time in the drafting room in this course as I believe that with the thorough training in engineering drawing which our students receive in the engineering drawing department they can take up the technique of structural drafting in the drafting room in a very short time and that their time in college is much more profitably spent in getting the fundamentals of design. The

records of the graduates of this department I believe will bear out this view.

For those specializing in municipal and sanitary engineering a three-hour course for one semester is given covering both stresses and design of simple roof trusses.

Concrete and Reinforced Concrete is required of all civil engineers and is given in two parts, a two-hour laboratory course in testing cements, aggregates and concrete mixtures, and a three-hour recitation and lecture course in reinforced-concrete design. In this latter course the methods of design of beams, slabs, tee beams, columns, etc., are taken up and a full-size reinforced-concrete beam is tested and extensometer measurements made so that the relations between the actual deformations and the theoretical are determined.

A thorough course in *Masonry Construction* is given to all civil engineers covering two semesters, four hours and three hours per week respectively. In this course is taken up a thorough study of the materials and the design of piers, abutments, foundations, retaining walls and similar masonry structures.

Two courses are offered which are optional and are taken by those wishing to specialize in structural work. These are *Advanced Bridge Design* and *Tall Buildings.*

The course in *Advanced Bridges* takes up the subject of cantilevers, swing bridges and arches. In this course an effort is made to give the fundamentals regarding the calculation of stresses in these types of bridges and also some work in design. Work in both steel and reinforced concrete arches is taken up.

The course in *Tall Buildings* commences with the design of the floor construction including the various types of reinforced-concrete and tile floors and then proceeds to the design of the floor beams and floor girders. After this follows the design of columns for (both central and eccentric loading) the wind bracing (both with and without diagonals), and finally the footings and foundations.

REPORT OF COMMITTEE NO. 15.

TRAINING OF INSTRUCTORS IN STRUCTURAL ENGINEERING.

BY J. HAMMOND SMITH,

Professor of Civil Engineering, University of Pittsburgh.

The essential qualifications of a good teacher may be summed up under the following headings.

1. He must have a commanding bearing in relation to his classes.
2. He must know his subjects thoroughly.
3. He must be able to inspire and lead his students.
4. He must be able to judge his students fairly.
5. He must maintain a congenial relation in general with his associates on the teaching staff.

The teacher must be in full command in his classroom, at all sessions, whether they be lectures, recitations or design periods The first requisite of any instructor is to maintain proper decorum. This may be often done tactfully—by substituting recitations and quizzes for what would ordinarily be explanatory lectures. If lectures do not receive proper attention from the class as exhibited by decorum and attention, they should be discontinued or given less frequently or reduced in scope, and a method more compelling laid down before the student; viz., recitations consisting of blackboard work with explanations before the class, or oral and written quizzes. The efforts of many lecturers are largely wasted because many minds in the class are wandering from the subject being presented. Even the best students will tire under a continuous lecture system. The author prefers to use a system of combined lectures, recitations and quizzes, and doubtless there are many others in the engineering teachers profession who are using practically the same methods. First the instructor should assign the lesson for the following period with any brief explanatory remarks which may seem necessary. Then he should explain clearly, and without too

much haste, the essential points in the day's lesson. If one-hour periods are used he may lecture for fifteen minutes, or if the scope of the subject for the hour is unusually large or complicated he may take the whole period and omit lecturing in the following period. He should review the subject in the text shortly before presenting it to his students, so that he can explain the essential points in such a way as to augment the students' book knowledge of the subject, instead of delivering the subject in a different manner or order and thus confusing the student. Usually the class should be encouraged to ask questions at the end of the instructor's lecture. These questions are generally a very good measure of the students' knowledge of the subject, although most students are not cognizant of this means of bringing them out in their true stature. It is highly important that the instructor resort to good diagrams or illustrations as an aid in making his lectures clear. If blackboard illustrations are used, they should be prepared, if possible, before the lecture. Great caution should be exercised by the lecturer in guarding against confusion, by presenting the lectures in the wrong order or by broadening the subject unduly, or reaching over into the following lesson unintentionally. This caution also applies when answering students' questions, as many students will ask questions beyond the lesson or not vitally related to the subject. Many teachers, just the same as many writers, do not appreciate the fact that a superfluity of words only serves to hide the basic essentials of the subject.

Following the lecture part of the period, a part of the class should be assigned problems to be worked out and later explained at the blackboard. The remaining part of the class should be given one general problem to be worked on paper at their seats, and the instructor should circulate among these students to make sure that they are using the proper methods of solution. It is a wise plan to use individual and original problems very frequently in addition to the problems found in the text.

The preliminary calculations in elementary design may be carried on to the best advantage by lectures with blackboard work to direct and check the students, who are at their seats or tables with notebooks and references. The calculations should be sufficiently full to permit the student to begin drafting with practically all required data in his notebook. If possible the preliminary design should just precede the work on the drawing board. Brief lectures may be interspersed through the drafting periods as would seem necessary to clear up points which were not definitely decided in the preliminary design.

An instructor in structural engineering should be a man who has had considerable experience in structural plants in addition to his course in engineering. He should be highly interested in his subject and constantly progressing, by means of laboratory research work and outside practice in the profession.

The heads of the various departments should keep in close touch with their instructors, especially with their new instructors. The latter should receive careful instruction on methods of teaching and scope of work to be covered.

The instructor should use tact and judgment in gaining the confidence of his students. He can then encourage greater effort by requiring of the student all he can accomplish, but no more. If a student is overloaded he is likely to lose confidence in himself, because he is unable to work out anything to his satisfaction. And it is satisfaction which promotes interest.

REPORT OF COMMITTEE NO. 21, MILITARY ENGINEERING.

The first conflicts between man and man were nothing more than the conflicts between two animals who used the weapons with which nature had endowed them. Physical or brute strength were the dominant characteristics, intelligence and skill were secondary, the prize of victory was existence and the cost of defeat was death.

As civilization developed and grew, physical strength became less and less a factor with the development of arms and appliances which put the small man on a par with the large, and gave the victory to the mentally rather than the physically great, so that to-day the mentally trained or educated is the superior to the moral, physically strong.

This has been called an engineer's war and the tremendous call for engineers has been well answered by our engineering schools.

A letter received from the Chief of Engineers of the United States Army indicates that the present courses are as a general thing well fitted for the service to be rendered in war.

The special education and training required has been outlined by the War Department in an official Bulletin from the Chief of Staff, Vol. I, No. 4, and in General Orders No. 49 from the War Department establishing the Reserve Officers' Training Corps. Copies may be obtained from Washington.

Course of training for engineers' units of the Senior Division is as follows:

1. Military Art.

Three hours a week (counting 14 units).

(*a*) Practical. Weight 10.

Physical drill (Manual of Physical Training—Koehler).

Infantry drill (U. S. Infantry Drill Regulations), to

include the School of the Soldier, Squad, and Company, close and extended order.

Practical military engineering—laying out and constructing trenches, obstacles, and revetments (Part V, Engineer Field Manual, and 584–595, Infantry Drill Regulations). Use sand table when outdoor work is impracticable.

(*b*) Theoretical. Weight 4.

Military organization (Tables of Organization).

Service of Security (Field Service Regulations).

Personal hygiene (lectures).

Part V, Engineer Field Manual (including latest addendum); omit mining and demolitions.

2. Military Art.

Three hours a week (counting 14 units).

(*a*) Practical. Weight 10.

Physical drill (Manual of Physical Training—Koehler).

Infantry drill (U. S. Infantry Drill Regulations), to include School of Battalion and Ceremonies.

First-aid instruction.

Range and gallery practice.

Practical military engineering—military mining and demolitions (Part V, Engineer Field Manual).

(*b*) Theoretical. Weight 4.

Lectures on general military policy as shown by military history of United States and military obligations of citizenship.

Service of Information (Field Service Regulations).

United States Infantry Drill Regulations, to include School of Company.

Camp sanitation for small commands (lecture).

Part V, Engineer Field Manual—military mining and demolitions.

3. Military Art.

Three hours a week (counting 14 units).

(*a*) Practical. Weight 10.

Same as course 2 (*a*) except practical military engineering, which will consist of knots and lashings and improvised military bridges.

(*b*) Theoretical. Weight 4.

United States Infantry Drill Regulations—School of the Battalion.

Small-Arms Firing Regulations, paragraphs 1–134.

Part II, Engineer Field Manual—Bridges.

4. Military Art.

Three hours a week (counting 14 units).

(*a*) Practical. Weight 10.

Same as course 2 (*a*) except practical military engineering which will consist of building military bridges, including floating bridges and instruction in rowing when practicable.

(*b*) Theoretical. Weight 4.

Lectures on recent military history.

Field Service Regulations—patrolling, advance and rear guard and outpost, orders and messages, marches, and camps and camp expedients.

Ponton Manual.

5. Military Art.

Five hours a week (counting 24 units).

(*a*) Practical. Weight 13.

Duties consistent with rank as cadet officers, non-commissioned officers, and instructors in connection with the practical work and exercises of the student taking courses 1 (*a*) and 3 (*a*).

Military reconnaissance and sketching.

(*b*) Theoretical. Weight 11.

Review of Parts II and V, Engineer Field Manual.

Notes on Field Fortification (Army Field Engineer School).

Part I, Engineer Field Manual—Reconnaissance. Weight 8.

Company Administration—general principles (papers and returns). Weight 1.

Two lectures on the History of Military Engineering (Students to submit notes on lecture). Weight 2.

6. Military Art.

Five hours a week (counting 24 units).

(*a*) Practical. Weight 13.

Duties consistent with rank as cadet officers, non-commissioned officers, and instructors in connection with the practical work and exercises of the students taking courses 2 (*a*) and 4 (*a*).

Military reconnaissance and sketching.

(*b*) Theoretical. Weight 11.

Review of military mining and demolitions in Part V, Engineer Field Manual.

Review of Ponton Manual.

Field Service Regulations, paragraphs 354–410, 242–246, and appendix 2. Weight 8.

Elements of international law. Weight 2.

Property accountability and methods of obtaining property (Army Regulations). Weight 1.

7. Military Art.

Five hours a week (counting 24 units).

(*a*) Practical. Weight 13.

Duties consistent with rank as cadet officers, non-commissioned officers, and instructors in connection with the practical work and exercises of the students taking courses 1 (*a*) and 3 (*a*).

Military reconnaissance and sketching.

(*b*) Theoretical. Weight 11.

Field Service Regulations—Article V, Combat.

The use of engineer troops—Official Bulletin No. 4.

Map reading and map maneuvers.

Manual of Courts-Martial.

8. Military Art.

Five hours a week (counting 24 units).

(*a*) Practical. Weight 13.
Same as course 7 (*a*).
(*b*) Theoretical. Weight 11.
Organization and equipment of engineer troops.
Night illumination of battlefield.
Studies in minor tactics (School of the Line, 1915).
Lectures on military history and policy, based on Upton.

The schedule of training prescribes graded courses covering a period of four years, and instruction will be taken up as follows:

BASIC COURSE.

Freshman year, courses 1 and 2 (28 units).
Sophomore year, courses 3 and 4 (28 units).

ADVANCED COURSE.

Junior year, courses 5 and 6 (48 units).
Senior year, courses 7 and 8 (48 units).

COURSE OF TRAINING FOR JUNIOR DIVISION, TOTAL WEIGHT 22 UNITS.

1. Infantry drill regulations (practical and theoretical, to include definitions, general principles, combat and ceremonies).

School of the Soldier.....
School of the Squad.....
School of the Company...
School of the Battalion...
} In extended order, combat, and intrenchments.

2. Manual of Interior Guard Duty (practical and theoretical). Duties as sentries; general principles.

3. Physical drills: Calisthenics, bayonet exercises, and combat fencing.

4. Military hygiene: To include principles of personal hygiene, camp sanitation, first aid to the injured, etc.

5. Military policy: A few lectures when in last year at in-

stitution on the military policy of the United States and the military obligation of citizenship.

6. Small-arms firing regulations: Preliminary instruction in rifle firing; sighting position and pointing and aiming drill; indoor and range practice; due attention devoted to fire direction and control and, if possible, some collective fire.

7. Administration and organization: A few lectures on company administration and tables of organization.

8. Map reading: Instruction in reading a contoured map (in connection with 9).

9. Field service regulations: Patrolling advance and rear guards; outposts, by means of the sand table and small map maneuvers; messages and orderly work.

10. Marches and camps: Simple camping expedients.

11. Signaling: Semaphore and flag.

Owing to the wide range of the ages of students in this class of institutions, the majority being too young to follow intelligently a graded course such as is prescribed for the senior division, only the subjects in which proficiency must be attained are laid down. It is impossible to set any fixed number of years for the accomplishment of this programme, and hence each institution should arrange its schedule of instruction so that the cadet upon graduation will be proficient in all of the above subjects.

Should the cadet enter a collegiate institution in which is organized a senior division of the Reserve Officers' Training Corps he will not have to repeat the theoretical work in any of the above subjects, but he will not be excused from any practical work. He will not, however, repeat any work in the school of the soldier or squad if the professor of military science and tactics judges him to be proficient in such schools.

The courses prescribed can be added to in case institutions so desire, but the minimum requirements quoted above must be completed upon graduation.

To those who sign the agreement to take these courses, the

Government makes a certain allowance in both uniform and subsistence.

For those in institutions close to the sea, similar work could probably be done for the Navy.

C. S. SPERRY, JR.,
J. N. BRIDGMAN,
C. J. TILDEN,
H. S. BOARDMAN,
L. S. RANDOLPH, *Chairman.*

AMERICAN UNIVERSITIES AND RUSSIA.

American universities and colleges are doing their part to strengthen the morale of Russian universities, according to a letter recently written to Hon. Robert Lansing, Secretary of State, by P. L. Campbell, secretary of the Emergency Council on Education, which represents the national organizations of American schools, colleges and universities. Dr. Campbell asked the Secretary of State to transmit to the faculties of the universities of Russia the text of a letter prepared by the Emergency Council in order to give sympathy and encouragement to the leading scholars of Russia. The following is the letter prepared by the Emergency Council:

With grave concern we have heard reports of the dangers and difficulties which have beset the universities of Russia. Unprecedented events have worked to disorganize the educational system built up with years of arduous endeavor in your land. As representatives of sister institutions in a country whose whole heart sympathizes with Russia in her danger, we offer to you our sincerest wishes for the unabated continuance of the great work in education which your nation has carried on, and the assurances of our unanimous desire to render all the help in our power. Threatened to-day by a relentless and materialistic military power, the world must unite to keep burning the pure flame of a learning which seeks the salvation of mankind. The ancient friendship of Russia and the United States of America renews itself to-day in the bond which education for a common end has forged between the universities of your land and ours.

(Signed) EMERGENCY COUNCIL ON EDUCATION.

EDITORIALS.

The War Department and Engineering Schools.—With the creation of the Committee on Education and Special Training of the War Department, we have an attempt for the first time in the history of this country to correlate the engineering schools with the direct and important needs of the government service. This experiment, which is being conducted on a very large scale, will demonstrate to the country that institutions of higher learning stand ready to provide that type of education which is needed in order that men may be trained efficiently for service with the government. While engineering schools will in this way contribute materially to the success of the war, they will also reap many benefits. For instance, the injection of new types of instruction into the curriculum, the repetition of courses with a frequency of about eight weeks, etc. Here is an opportunity to make careful studies of educational problems because of the results of modification in methods of teaching which are immediately available. It also provides excellent opportunities for trained teachers to train other teachers and thus themselves to become better trained. The effect of this kind of work on engineering education will without doubt be marked in at least three ways: (1) The modification of the curriculum; (2) modification of the types of instructors employed; (3) some modification in entrance requirements.

How to Study.—In these strenuous times it is interesting to note that at least one prominent engineer is interested in this important subject. A little booklet has recently been issued by Professor George F. Swain which has been widely used in various institutions, especially with freshmen. In one institution, for instance, three class periods have been devoted to the discussion of the contents of the book and each student

required to prepare a theme describing his own method of study as compared with those described in the text. This subject is important in connection with the training of soldiers because of the necessity of developing in a large group in a short time some ability to study.

Further Information Regarding the Northwestern Meeting, June 26–29.—It is suggested that as guests arrive at Evanston they go directly to the Lindgren House, the center house in the dormitory group on the North Campus, where arrangements may be made for rooms and meals.

The nearest elevated station is Noyes Street—the campus is two blocks east.

The nearest Chicago and Northwestern station is Davis Street. A convenient way to reach the campus is to walk to Sherman Avenue one block east and take a street car to Noyes Street.

The meetings will be held in Swift Hall of Engineering, a short distance south of the dormitories.

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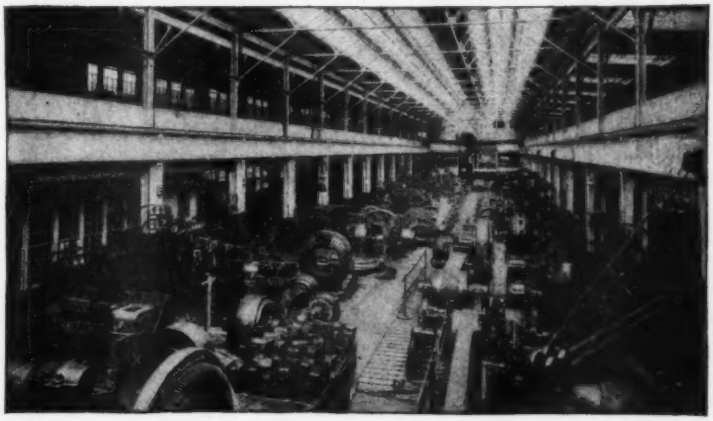

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The Elements of Calculus

By Franklin, MacNutt and Charles. **Price, $2.00 postpaid**

The excessive amount of classroom coaching, which seems to be necessary in the mathematical sciences, is the despair of every teacher who tries to develop in his students the power of analytical thinking. Too much coaching is altogether bad, and to resort too much to the formal task-aspect of mathematics is but little better. What is the teacher to do? Franklin, MacNutt and Charles believe that the best solution of this difficulty would be to use a clearly and even vividly intelligible text book, and exact from the student a very considerable amount of verbal recitation, oral or written, with never-failing insistence on precision and accuracy. Everyone knows how arithmetical ideas are classified and strengthened by old fashioned mental, or let us say, verbal arithmetic; and a kind of emphasis akin to verbal arithmetic is seriously needed in the teaching of calculus.

Franklin, MacNutt and Charles' **Calculus** does not side-step mathematical precision and rigor, decidedly it does not, and it contains more than enough carefully graded problem work to keep the average student busy for a year. The book is intended to supply a reasonable basis for verbal, or, let us say, philosophical exactions as well as for formal exactions in the class room, and those who have used the book seem to think that it does, in fact, do this to an unprecedented extent.

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